ASSESSMENT OF INNOVATIVE WORKS IN BUILDING CONSTRUCTION INDUSTRIES IN ABUJA, DISTRICT COUNCIL OF FEFERAL CAPITAL TERRITORY (FCT) ABUJA, NIGERIA.

BY

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2018/3/74395TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

FEDERAL UNIVERSITY OF TECHNOOGY, MINNA

APRIL, 2023

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A RESEARCH PROJECT SUBMITTED TO THEDEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATIONFEDERAL UNIVERSITY OF TECHNOOGY, MINNA

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DECLARATION

I **THOMAS HAPPINESS ADZUME** with the Matric No**: 2018/3/74395TI,** an undergraduate student of the Department of Industrial and Technology Education, Federal University of Technology Minna, certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other university

HAPPINESS ADZUME THOMAS

………………………..

Name Signature & Date

CERTIFICATION

This project titled " Assessment of Innovative works in Building Construction Industries in Abuja, district council of Federal Capital Territory (FCT) Abuja, Nigeria" has been read and approved as meeting the requirements for the award of B. Tech degree in Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna.

Dr Ibrahim Dauda ……………………..

Supervisor Signature &Date

Dr Saba. T. Moses ……………………

Head of Department Signature & Date

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External Examiner Signature & Date

DEDICATION

This work is dedicated to my beloved parents Mr/Mrs Thomas and Saratu Angbaki.

I also dedicate this work to all the Building Construction Practitioners; they have been my source of inspiration, also to my dear country Nigeria.

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Glory, honor and power be unto God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I would like to express my special thanks of gratitude to my supervisor, Dr Ibrahim Dauda who gave me the golden opportunity to do this wonderful project on the topic; Assessment of Innovative works in Building Construction industries in Abuja, district council of Federal Capital Territory (FCT) Abuja, Nigeria. I specially acknowledge him for his encouragement, suggestions and support from an early stage of this research, and the vital contributions as and when required during this research. His involvement with originality has triggered and nourished my intellectual maturity that will help me for a long time to come. I am proud to record that I had the opportunity to work under an exceptionally experienced Doctor like him.

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Abstract

This study was designed to determined the Innovative works in Building Construction Industries in Abuja, district council of Federal Capital Territory (FCT) Abuja, Nigeria. Three research questions and three hypotheses guided the study. Survey research design was adopted for the study. The study was conducted in building Construction industries in Abuja. The total population consisted of 60 respondents which include 36 Builders and 24 Project Managers. A structured questionnaire developed by the researcher was used for data collection. The structured questionnaire was validated by three experts from the Department of Industrial and Technology Education (ITE), Federal University of Technology Minna, Niger State. The instrument was administered to the respondents with the help of research assistant. Mean and standard deviation was used to analyze answers to the research questions while t-test was used to analyze the hypotheses at 0.05 level of significance. Findings of the study revealed that Builders and Project Managers were well informed of the Innovative works in Building Construction Industries in Abuja. It also revealed that the biggest challenge limiting the adoption of innovative works in building construction industries is; incompetent project management skills and strategies with the total mean of 3.38 above the average.

Based on the findings, it was recommended that the adoption of innovation as an inquiry based strategy in boosting the industry performance, particularly its productivity and efficiency should be encouraged by industrial managers and embraced by Builders/contractors, project/site managers, architects in an effort to continually improve the overall quality of building construction projects , with better project results, value for money, sustainability, proper health and safety for employees, and projects that are both cost- and environmentally-efficient.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The construction industry is a major economic sector, but it is plagued with inefficiencies and low productivity. Innovative works such as Building Information Modeling (BIM), 3D printing, Robotics and contemporary building materials have the potential to address these shortcomings; however, the level of adoption in the building construction industry is very low.

The low level of adoption of innovation in the building construction industry is widely acknowledged such that in order to increase industry production and efficiency, the building industry has to change from its conservative old ways to more creative practices (Holt, 2013; Xue et al., 2014). The building industry has several difficulties with regard to productivity and performance, achieving quality standards, and implementing innovation (whether it be in terms of technology, skills, or procedures) (Owusu-Manu et al., 2015; Dansoh et al., 2017). According to Harty(2008), the construction industry requires a disruptive revolution to help increase productivity and efficiency, but is constrained by a lack of effective innovation. According to Hardie and Newell (2011), a lack of investment in research and development limits innovation in the building construction industry.

Building construction performance is first sparked by innovation within the industry. Innovation is clearly needed in today's world. Each and every economic area is propelled forward by innovation. Many variables affect someone's willingness to innovate in any way. The state of the market's economy is the first factor. Innovation is dynamic and continually modifying itself as it progresses. The way that innovation is defined varies greatly. An idea, behavior, or thing that is recognized as novel by a person or other adoption unit is called an innovation (Rogers, 2003). An idea's novelty makes it appear to a receiver as an invention (Lu and Sexton, 2007; Gledson and Phoenix, 2017). To increase the value of goods, processes, and services, one must create and implement new knowledge (Aouad et al., 2010). The definition of innovation includes creativity, entrepreneurship, process improvement, development, and growth (Gledson and Phoenix, 2017). New modifications that are created adopted and implemented inside the industry (Lai et al., 2016)

Innovation is described in the above definitions as anything that involves novelty, advancement, and transformation. The appropriate definition of innovation in the context of building construction and for the purposes of this study is the development and adoption of novel concepts, procedures, and methods that alter and enhance output, effectiveness, performance, and quality. Innovations are divided into technical and non-technical categories, according to Gledson and Phoenix (2017). Technical innovations are further classified as product and process-related (technological), whereas non-technical innovations are specifically referred to as business improvement innovations (non-technological), which are frequently concerned with changes in organizational structure, culture, management techniques, and strategic direction (Murphy et al., 2015; Richardson et al., 2016).

Improvements to industry practices are reportedly required in the building construction industry, according to a number of international studies (Brege et al., 2014; Hemstrom et al., 2017); better management of architectural practices; reduction of process wastes through the application of lean management philosophies; Höök and Stehn, 2008; and creation of new contractual arrangements (Kadefors et al., 2013); and the use of fresh ideas and innovations like building information modeling (BIM) (Jensen and Johannesson, 2013; Hemstrom et al., 2017). Notwithstanding these realizations that the building industry has found is challenging to adapt industrial practices (Sunding and Ekholm, 2015;Hemstrom et al., 2017).

In order to inspire the global industry, the World Economic Forum (2016) established a framework for industrial transformation. The forum identified a few steps, including promoting collaboration that can stifle industrial innovation in order to boost industry performance, particularly its productivity and efficiency. Best practices for fostering innovation complement these actions. These frameworks offer tactics and a broad perspective on how to disrupt the construction business and build a more creative sector. The World Economic Forum (2016), Clark Reynolds and Pelosi (2016), and World Economic Forum (2016) all made the case that the adoption of new and emerging technologies might be sparked by locally oriented solutions.

The current study assess how innovation, emerging technologies, such as Building Information Modeling (BIM), 3D printing, robotics and automation, drones, prefabrication and modularization, virtual (VR) and augmented reality (AR), and contemporary building materials, can influence the future of the building industry in Nigeria. This is done through the participation of industry practitioners. The study assesses how building construction professionals perceive these innovations which can also help to boost the performance of the building construction outcome.

The boosting of the building construction outcome can also be as a result of other innovative works such as; Drones, safety devices, and site sensors that track temperature, noise levels, dust particles, and volatile organic compounds to assist limit worker exposure. There are many advantages to using advanced technology when building a structure, so it is crucial that Nigeria's building construction industries keep up with technological advancements by utilizing methods for structural analysis, design processes, facilities management, and health and safety procedures. As a result, construction and engineering projects will be of higher quality overall, with better project results, value for money, sustainability, proper health and safety for employees, and projects that are both cost- and environmentally-efficient.

1.2 Purpose of the Study

The purpose of the study is to assess the innovative works in building construction industry in Abuja district council of Federal Capital Territory (FCT), Abuja. Specifically, the study seeks to assess.

1. The innovative works (advanced technologies) in building construction industries.
2. The challenges in adopting innovative works in the building construction industries.
3. The recommended strategies to promote the adoption of innovative works in the building construction industries.

1.3 Statement of the Problem

The move to adopt innovative works such as Building Information Modeling (BIM), 3D printing, robotics and automation, drones, prefabrication and modularization, virtual (VR) and augmented reality (AR), and contemporary building materials, in Building construction industry (client side) and amongst different building practitioners (Builders, Project Managers, Architects, Quantity Surveyors, Engineers etc.) has been very slow. Few of these practitioners have adopted but mainly for enhancing the visual quality of their presentation. This is unfortunate because of its enormous potentials to enhance efficiency (improves building construction outcomes), sustainability, cost efficient, reduce disputes, provide environmentally safe buildings and overall quality of building construction works, and curb corruption (Alufohai, B. 2012). A major setback to the full adoption of innovative works in building Construction industry, as with every novel technological innovation across the globe, could be related to incompetent project management skills and strategies which when taken into cognizance could make research and development and investment in innovation and collaboration possible - along with the benefits of improving productivity and efficiency in the building Construction sector - amongst stakeholders. Although few studies have been done on adoption of innovation among the building construction practitioners. Studies on why the building construction industries have not fully and practically adopt innovative works are still in an embryonic stage. It is thus imperative, as a first step, to assess the major challenges in adopting innovation in the building Construction Industry. This in turn, will serve as a basis for developing strategies for increased recognition of the value of the innovations in order to encourage a holistic implementation of these innovative works by all building construction industry participants, and thus, achieve the needed productivity and efficiency in the building Construction Industry.

1.4 Significance of the study

The study's findings as well as recommendations will be very valuable since they will highlight the scope of innovative efforts and the challenges in adopting and implementing them in the building construction sector. The client (owner), designer/architect, builders, contractor, the whole building construction industry, and society at large will all profit from the discoveries in the context of building construction.

The client (owner) will profit from the findings since it will broaden his or her knowledge and expertise on the processes involved in building construction projects, which will aid in selecting an effective design team, coming to the best option, and allocating finances for the project's execution.

The study will help the designers by releasing their potential to learn more about modern design tools after working with antiquated building design techniques. Although some architects and designers may perform well or averagely when using advanced software to execute architectural projects, their reliability may be low, enabling the effect of governmental policy.

Builders are the people that translate architectural and design plans into physical form. This study will show them how to get better at their jobs with high performance and outstanding productivity by locating the materials that have been specified in the drawing or design and choosing the best approach and solution to complete a suitable building project.

This study will inform, reaffirm, and assist the contractors in understanding the need of performing regular site inspections to check the quality of work, spot any issues as soon as possible, and ensure that work on the ground complies with plans or designs on paper. The ability to employ more advanced and cutting-edge construction software created specifically for efficient project planning and work team management will also help contractors be better at what they do.

The study will assist Abuja in moving away from some of the outdated building construction techniques that provide less-than-ideal results to the new techniques that produce results that are more effective and of higher quality overall.

1.5 Scope of the Study

This study assesses the innovative works in building construction industry in Abuja, district council of federal Capital Territory (FCT) Abuja. Therefore, this study will be strictly carried out among the building construction practitioners of **Abuja** metropolis from all field of building construction.

1.6 Research Questions

i) What are the innovative works in building construction industry?

ii) What are the challenges in adopting innovative works in building construction industry?

iii) What are therecommended strategies to promote the adoption innovation in building construction industry?

1.7 Research Hypotheses

The following null hypotheses were formulated and will be tested at 0.05 level of significant

HO_1: There is no significant difference in mean responses of the builders, and the project/site managersas regards the innovative works in building construction industry

HO_2: There is no significant difference in mean responses of the builders, and the project/site managers as regards the challenges in adopting innovative works in building construction industry

HO_3: There is no significant difference in mean responses of the builders, and the project/site managers as regards the recommended strategies to promote the adoption of innovation in building construction industry

CHAPTER TWO

LITERATURE REVIEW

2.2 Theoretical framework.

This study was based on the theoretical framework of innovative works in building construction.

2.2.1 Rogers's theory of Innovation (Diffusion)

This theory, which focuses on comprehending innovation terminology and using them appropriately, was proposed by Everett Rogers (2010). Innovation is the introduction of anything new, and this new item may be an idea, construct, method, or product. He claimed that the phases of idea formation, idea development, and idea implementation—which overlap—are how innovation occurs. When a person or the construction industry enacts an innovation, this is referred to as implementation (Barret and et.al, 2015).

This theory provides the framework for comprehending innovation and putting it into practice to enhance the efficiency of a building construction project and to meet client demands. Awareness of the need for an invention, the decision to accept or reject the innovation, the initial use of the innovation to test it, and ongoing use of the innovation are the stages by which a person accepts an innovation and wherefore dissemination is accomplished.

Rogers's theory of Innovation *seeks* to explain how new ideas or innovations are accepted, and this theory proposes that there are five attributes of an innovation that effect acceptance:

i. Relative advantage,

ii. Compatibility,

iii. Complexity,

iv. Trial ability,

v. Observability.

The degree to which an invention is thought to be superior to the concept it replaces is known as **relative advantage**. According to Rogers' idea, innovations that offer a distinct benefit over the current method will be more readily accepted and used. According to recent studies, an invention won't be adopted if a potential user sees no comparative benefit from employing it.

The degree to which an innovation fits with the values, experiences, and requirements of potential adopters is referred to as **compatibility**. Strong direct study data suggests that the chance of embracing an innovation increases with how compatible it is.

The degree to which an innovation is deemed to be challenging to comprehend and use is referred to as its **complexity.** Moreover, Rogers proposed that new innovations may be classified along a complexity-simplicity continuum with the qualification that the innovation's significance and applicability might not be fully grasped by potential adopters. Key players will more readily adopt innovations if they believe them to be user-friendly.

The extent to which a new idea can be tested out in a small setting is known as its **trial ability**. Innovations that can be tested before being completely implemented are more easily embraced since new ideas entail spending time, energy, and money.

The degree to which an innovation's outcomes are apparent to those who adopt it is referred to as **observability**. An innovation is more likely to be accepted if it produces demonstrable benefits.

Advantages of Rogers's theory of Innovation.

The Rogers' theory of innovation aids in raising awareness of the need for innovations and aids in making decisions about whether to accept or reject them by helping people grasp the terminology used in innovations correctly. To the contrary, the of Rogers's theory of Innovation doesn't take into account an individual's resources or social support to accept the new behavior or innovation.

The Rogers' theory of innovation is relevant to this study since it directs attention to trends, innovations, and new ideas while recognizing how crucial it is to decide whether to accept or reject an invention. This is based on how pertinent and unambiguous the innovation is in providing improved performance of the building construction projects.

2.1.2 Lean construction theory

Given the flaws in the time-costs-quality tradeoff paradigm, LauriKoskela (1992) developed the Lean construction theory. Considering how well a building project can be planned, carried out, and controlled to achieve a desired result, Koskela and Howell (2015) presented a review of the existing theory. The idea behind lean construction theory is to apply lean thinking to the design and construction process. This leads to pleased clients and increased productivity for the builder.

The major goal of lean construction theory is to maximize the value of what the customer wants while lowering project costs overall, the amount of materials used and lost during construction, as well as the time it takes to complete the project. By optimizing the utilization of resources and technology to provide flawless outputs, lean focuses the construction management on customer satisfaction. Waste reduction is done in line with a focus on the value of the client. Elimination occurs throughout the whole process rather than at discrete, specific instances. Also, it makes room for less labor-intensive operations that take less money and time to complete.

Lean construction theory's foundational principles include developing a planning- and data-based environment, cutting waste, and improving customer-company communication to provide flawless products and ensure full client satisfaction**.**

Advantages Lean construction theory

The following are some of the Advantages of Lean:

i. Lean construction theory uses lesser materials which greatly reduces the overall costs. However, the goal is to provide customer satisfaction as end result with the reduced cost.
ii. Lean construction theory helps to focus on smart work rather than hard work by making strategic plans for the future.
iii. Lean construction theory Promotes worker safety and fewer accidents for maximum productivity.

Lean construction theory has many benefits, but for it to be effective, all parties participating in the project—from the owner to the engineer to the workers—must adhere to its guidelines. They ought to be on the same page. There will become a weak link if one of them doesn't follow, which lowers production. Likewise, the benefits of lean construction theory take time to manifest since they are quite uncommon. With all the new regulations and processes, educating staff also takes a lot of time and money. Planning and communication are encouraged by lean construction philosophy. Clients, designers, contractors, and suppliers must all commit to co-operating in this integrated process in order to deliver the desired performance.

The Lean construction theory is relevant to this study because it focuses on improving the use of technologies and assets to give perfect results while reducing overall project costs, the materials needed and wasted during the construction process, as well as to shorten project duration. This study aims to increase the value of what the client wants, i.e. client satisfaction.

2.1.3 Fayal’s theory of construction Management

According to Adeagbo S. Mohamed (2020), Henry Fayol's theory of construction management and the usage of digital project management were both influenced by the complicated nature of building operations, which entail the struggles of numerous stakeholders to meet client objectives.

Management is viewed as a process that enables businesses to set their goals through planning, organizing, controlling, and the employability of their workforce. Construction projects contain several activities including more individuals as a team working towards accomplishing organizational purpose and target, therefore management skills are required to increase an organization's performance (Kehinde et al., 2017). Moreover, Adeagbo et al (2019), conclusion states that years of project managers' experience have a substantial link with the use of these theories on construction sites for managing human resources. As a result, according to Fayol's theory of construction management, workers perform better at their jobs when they are assigned tasks that are specific to their areas of expertise and when an idea-sharing platform is introduced so that workers may collaborate to exchange and develop new ideas. Thus, it is crucial that the task be broken into smaller components and managed by a variety of specialists (Uzuegbu&Nnadozie, 2015).

Advantages of Fayal's theory of construction management

This theory has the benefit of constructively addressing human behavior depending on the current circumstance and also offering a framework for an overview of organizational decision-making (Godwin et al., 2017). It supports staff performance and boosts productivity by identifying innovative approaches to achieving client or project objectives.

Disadvantages of Fayol's theory of construction Management.

Fayol's approach has several benefits, but in order to use it properly, construction managers and contractors need to be highly qualified and experienced. Employees must be trained, which takes a lot of time and resources because this theory demands highly qualified and experienced workers.

The Fayol's theory of construction management is relevant to this study since it emphasizes productively managing human behavior based on the existing circumstances and also offers fresh approaches for achieving client/project goals and objectives.

2.2 Conceptual framework.

The related literature was reviewed under the following sub-headings: Concept of Assessment, Concept of innovative works, Modern innovation technology, Modern building material, Overview of the Nigeria construction industry, Innovation and the building construction industry.

2.2.1 Concept of Assessment

The 2017 edition of the Webster Dictionary defines assessment as an appraisal. As a result, this procedure is frequently used in the construction industry to evaluate the quality of buildings and construction methods. This is done to inform the building construction industry of further steps that may be taken to enhance the performance of the building construction projects that the industry is offering.

The systematic gathering, examination, and application of data about something or a set of services for planning, decision-making, and quality improvement is known as assessment. An evaluation of new or existing building designs can be done quantitatively using a building assessment. There are several techniques for evaluating buildings, and each particular approach—such as the rating method and the multi-criteria decision-making method—is supported by a set of evaluation criteria and an evaluation mechanism. Building specialists developed the evaluation mechanism or assessment technique itself in light of the general features of buildings, and to make the assessment method easier to use, the evaluation criteria were either quantitatively or qualitatively specified.

2.2.2 Concept of innovative works

Simply said, innovative works are the imaginative and cooperative introduction of new technology and new construction materials that result in eco-friendly, energy-efficient, durable, and lightweight structures that will look great and be highly useful at the same time. New architecture that is completely unrelated to what we are used to is being stimulated by these developments. Products or methods that deviate from conventional building methods are considered innovative works. The efficiency and sustainability of a company's building process are further improved by these innovations.

Innovation, according to Kevin Mc-Farthing (2015), is the introduction of novel products or services that benefit the company. Toole (1998) defines innovation as the application of technology that is novel to an organization and significantly enhances the design and construction of a living environment by lowering installation costs, boosting installed performance, and/or streamlining the operational procedures. Paul Hobcraft (2017) asserts that innovation is the primary means through which a business creates ongoing value for its clients' businesses or personal lives, and as a result, for its shareholders and stakeholders. According to Egbu et al. (1998), innovation may be defined as the effective exploitation of novel ideas that are novel to the unit being adopted. New concepts in the field of building might take the shape of methods, items, technology, and markets.

Innovation, according to Jeffrey Baumgartner (2017), is the use of innovative thinking in order to produce value, typically through greater profits, decreased expenses, or both. Davey-Wilson (2001) (2001) When new techniques are required to enable the building of anything faster, more affordably, or under different circumstances, innovation in the construction process is necessary. Something that is novel, practical, and unexpected is innovation, according to Drew Boyd (2018). Due to the fact that not many people often discuss this last criterion, it tends to "surprise" individuals. Great inventions, in my opinion, are those that are straightforward and leave you scratching your head and wondering why you never came up with them before. Future delivery comes through innovation. The execution of a concept that answers a particular difficulty and creates benefits for the company, the client, is the pinnacle of innovation. Innovation, according to Dewick and Miozzo (2002), is "the use of tools and machinery, procedures, products, and mechanisms for delivering those products that are sustainable (because they conserve energy and natural resources, lessen the environmental impact or footprint of human activity, and protect the environment)."

2.2.3 Modern innovation technology

There are ten modern innovation technology. Which will be discussed as follows:

1. Building Information Modeling (BIM)

The Royal Institute of British Architects (RIBA), Construction Project Information Committee (CPIC) and Building Smart have jointly defined Building Information Modeling (BIM) as “the digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition” (The BIM Hub, 2014).Akerele and Etiene, (2016), have described BIM as a design and collaborative tool used in the procurement of construction projects.

According to Autodesk (2016), BIM is a method based on intelligent 3D models that aids professionals in the AEC sector in effective planning, designing, building, and managing infrastructure projects. From the above definitions, it can be inferred that BIM has been viewed from four main perspectives: as a structured dataset describing a building; as a tool for creating building and project information; as the act of creating a building information model; and as a business structure or system for effective building planning and designing is a cooperative activity that receives input from multiple individuals including engineers, architects, builders, and clients, as well as pros and cons. When everyone worked on their own records, it became difficult to notice changes in real-time using the conventional knowledge. This phenomenon generates multiple interpretation of the same plan and causes confusion. The Advanced BIM tools solve this problem by providing a central information or database and enabling everyone to work on a single shared model. While 5D

BIM allows for the cost and time overlays, 6D BIM also accounts for energy budgeting. These solutions determine clashes during the initial stages and improve overall workflow efficiency.

2. Construction Robotics

According to Chang-Richards et al., (*2020),* Robotic technologies for building construction represent a significant embankment from conventional construction approaches. The use of robots is likely to bring a host of opportunities that transform the way we design and construct buildings. Robotic technologies for on-site construction are a growing application field, where additive manufacturing (AM) and robotic bricklaying have a potential to influence the development of robotics in building construction. It is suggested that the building construction industry and could benefit from the current product and work processes that can be improved by taking some measures through innovative construction materials, improved robotics hardware, and more advanced engineering design to streamline construction workflows to achieve a complete on-site robotic system.

The construction industry is one of the most labor-intensive since it involves a lot of ongoing, time-consuming operations that can be completed more quickly with robotics and automation. Robotic construction workers significantly lessen human mistake and fatigue-related losses. Collaborative robots, for instance, precisely automate continuous operations like painting, rebar tying, welding, and many other repetitive ones. Robotics systems automate fleets, heavy machinery, and tools for demolition, load lifting, concrete work, and excavation. This improves safety for construction workers while also accelerating operating speed. Robotic construction boosts project productivity overall, decreases the need for manpower, and offers safety for operations that are risky or hazardous.

3. Construction Project Management

The newest trends in the construction sector are digital project management, which makes use of cloud-based software to meet quality, schedule, and cost objectives. For each stage of building, project management already has established principles. The project manager employs AI-based prediction algorithms in the early stages to assess the project's viability. Upon approval, the manager uses enterprise resource planning (ERP) software to divide the resources and establish milestones for everyone. Cloud-based technologies, in addition to ERP software, provide transparency and enable large-volume data storage. Such software is also used by managers to monitor the predicted and actual results of each task and to identify any bottlenecks. Managers create block chain-based smart contracts at the conclusion of the project to confirm legal responsibilities and stop financial fraud. In this approach, digital construction project management cuts down on waste, boosts worker productivity, and guarantees project completion by the deadline.

4. Construction Worker Safety

According to ObaidallahElhassanet. al., (2018) civil and building construction sites are considered as one of the riskiest environments where many potential hazards may occur. To protect construction workers and prevent accidents in such sites, a new design for an autonomous system that monitors, localizes, and warns site laborers who avail within danger zones. The proposed system is user-friendly, and its architecture is based on Internet of Things (IoT) which is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction Alexarder S. Gillis (2022). An online middleware backend server incorporates the heterogeneous parts of this architecture with no noticeable gaps. The suggested method uses a combination of three approaches to reliably recognize and identify construction workers. These are: (a) directional antennas (b) a radio frequency of 868 MHz, and (c) ultrasonic waves of 40 kHz. A sensor unit that guarantees thorough coverage and a wearable gadget for employees protect the back of the vehicle. A radio transceiver (transmitter/receiver), a wake-up sensor, and an alarm actuator are among the design elements of the wearable device. Safety as the name implies is always the number one point to be remembered by every working organization like the building construction sector yet worker safety still remains one of the most overlooked areas in the construction industry since companies look to minimize labor costs. Increasingly, modern-day construction strictly complies with worker safety rules. While immersive technologies prevent probable onsite accidents, Personal Protective Equipment (PPE) acts as a life saviour. Construction companies use AI algorithms to predict hazards and take safety measures accordingly. Virtual Reality VR (these are headsets that completely take over one's vision to give you the impression that you are somewhere else) technologies train field workers for hazardous tasks via immersive training to reduce accident probability while Augmented Reality AR (these are smart glasses that are transparent, letting you see everything in front of you as if you are wearing a weak pair of sunglasses.) allows fabricators to scan through the objects. To ensure worker safety, companies use PPE embedded with Internet of Things (IoT) sensors. The sensors detect signals in the form of vibrations, temperature, heart rate, steps, and more and send the information for further analysis. This allows supervisors to remotely monitor workers' health condition and productivity.

5. Construction Monitoring

It is challenging to manually supervise projects since they are geographically dispersed, involve numerous resources, and require a lot of labor. Several sections on building sites are inaccessible to humans but yet need to be checked often. For this reason, technology is being embraced by the construction industry to simplify construction monitoring. The degree of the monitoring process, which ranges from a light audit function (CM1) through quality assurance, determines the value addition from monitoring (QA). Modern monitoring and inspection methods combine thermal sensors with drone-based surveillance. High-definition (HD) cameras and AI-based facial recognition methods are used for construction worker monitoring to increase efficiency. Robots can more accurately identify structural flaws and failures using integrated sensor technology than humans can. As a result, entrepreneurs provide services or goods to boost construction monitoring are overall effectiveness. The technology also provides transparency because every step is controlled by a project database.

6. Green Building

Carbone I. et al., (2017) green building is regarded innovative and environmentally sustainable materials that reduce the production of pollutants. It is recognized that world construction is responsible for substantial amounts of harmful emissions. Research and findings demonstrate the expanding significance of green building as a sector of the whole construction industry and serve as a baseline for measuring environmental effect, water efficiency, and benefits to occupant health, comfort, and happiness.Green building is the process of constructing and running a building structure with consideration for the environment. Several new developments in the building business are centered on sustainability. For building projects, it is currently time-consuming and expensive to discover sustainable materials or procedures. Popular green building practices range from pre-construction planning all the way through project completion and decommissioning.

Green structures eliminate waste during construction, maximize resource and energy use, and allow structures to reach net-zero carbon emissions. Depending on the aforementioned factors, different certifications categorize buildings as green or sustainable. Leadership in Energy and Environmental Design, generally known as LEED, is one of the most well-known accreditations. council for green buildings. More and more, cutting-edge materials used in construction are LEED-certified. Startups are creating solutions to promote green construction since green buildings are the future of the construction sector.

Effective Building creates a Green Building Materials Database

Israeli startup Effective Building provides a green building materials database to assist construction companies in implementing green building projects. The startup collects technical and functional data of the certified green products and allows users to filter for materials by technical properties. This simplifies the process of material selection for all green building projects and significantly accelerates material sourcing for projects. The startup aims to make green building affordable and accessible for all building.

7. 3D Printing

According to NurhalidaShahrubudin et al., (2018) Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. 3D printing technology is a fast-emerging technology. Nowadays, 3D Printing is widely used in the world. 3D printing technology increasingly used for the mass customization, production of any types of open source designs in the field of construction, agriculture, in healthcare, automotive industry, locomotive industry and aviation industries. 3D printing technology can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. This paper presents the overview of the types of 3D printing technologies, the application of 3D printing technology and lastly, the materials used for 3D printing technology in manufacturing industry.

According to NurhalidaShahrubudin et al., (2018) Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from of materials. 3D printing technology is a fast-emerging technology. Nowadays, 3D Printing is widely used in the world. 3D printing technology increasingly used for the mass customization, production of any types of open source designs in the field of construction, agriculture, in healthcare, automotive industry, locomotive industry and aviation industries. 3D printing technology can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. 3D printing in construction, also known as additive construction, is a sustainable and efficient method of construction. Construction printers either print entire buildings or only prefabricated building components. 3D printing is a robotic approach that prints the design layer by layer with advanced construction materials in collaboration with BIM. It has high design flexibility without the need for formwork. The various methods used for printing are extrusion, power bonding, and additive welding. Comparatively, 3D construction printing produces less waste and requires fewer labour resources than traditional brick construction methods. It is a fully automated and programmed process that also eliminates human error and improves productivity. Many start-ups manufacture 3D printers or offer printing services for small-scale and large-scale projects.

3D Build Systems enables 3D Concrete Printing

US-based start-up 3D Build Systems builds concrete printing robots that create durable, scalable and customizable structures using a concrete mixture. It targets workforce, skilled, veteran, and retirement markets to provide them with economical and cost-effective solutions. 3D concrete printing technology serves the needs of large-scale construction and immediate housing. The startup’s robotic solution significantly reduces construction time by printing walls in 12-24 hours. Moreover, the robots are compatible with any 3D modelling software and also print up to a height of 7 meters. The start-up provides economical and well-constructed housing using robotics and 3D printing technology.

8. Connected Construction Site

Construction projects have many dynamic parts and controlling all the elements is crucial to project success. One way to ensure smooth operations is through connecting construction sites. Creating structured workflows and integrating data at each step of construction works ensures the availability of the right information to each stakeholder. Connected construction sites bring together people, processes, and information using augmented reality, virtual reality, artificial intelligence (AR, VR, AI,) robotics, and wearable Internet of Things (IoT) technologies, in combination with AI, enable predictive logistics to improve worker safety during construction and also optimize inventory to reduce wastage and related costs. Computer vision enables instant support and guidance, connecting construction sites to the main office. Such solutions allow managers to make faster and more informed decisions based on real-time

The software provides AR calling between the field and distant office experts in the same augmented environment. It allows experts to collaborate more effectively with the ground staff. This improves communication efficiency which, in turn, reduces machine downtime and increases productivity.

2.2.4 Modern building material

A lot of interest has been shown in the creation of "environmentally friendly" materials, according to Ezgi B.A. and Havva D. O. (2015). This is because of rising environmental concerns, regulatory pressure regarding plastic waste, and a sharp rise in the price of petroleum. One of the most advanced eco-friendly materials recently created is bioplastic. They benefit from factors like reduced carbon footprint, independence, energy efficiency, and eco-safety.

In terms of manufacturing volume and practical uses, silica aerogels are popular, according to Zahra Mazrouei-Sebdani et al. (2021). Aerogels may be appealing for acoustic applications because of their potential to help with sound absorption and insulation, even if the present market growth rate is solely driven by thermal insulation. Modern building materials are a complement to the new methods of construction as the building construction industry moves toward more conventional and environmentally friendly methods. Transparent wood, Aerogel, Bioplastic, Richlite, and Hydro ceramics are just a few of the new, environmentally friendly materials that are replacing the more traditional ones.

Transparent Wood

The invention of the newest eco-friendly material — transparent wood — was announced back in 2016. However, it was only in 2020, that the scientist, who invented a method to make wood transparent in collaboration with a team from the University of Maryland at College Park, stated that the tests were completed and that they had achieved a stable result. Transparent wood is more thermally efficient and at least five times stronger and lighter than glass. Because to these qualities, it presents a fascinating alternative to glass or plastic windows. Also, the raw material is environmentally benign and renewable. The balsa tree develops swiftly; it takes about 5 years for a tree to reach adulthood. The cost of manufacturing is also far cheaper than that of making glass, which leaves a significant carbon footprint due to the high temperatures needed and the power utilized in the process.

Transparent wood is quite flexible, as it contains natural cellulose. In order to achieve transparency, balsa wood is soaked in a special solution and then epoxy resin is added to the structure. Transparent wood or wooden glass can be used instead of traditional glass units or other elements in building structures that have to be transparent, but also durable, eco-friendly, and energy-efficient.

Aerogel

99.8% of the world's toughest and lightest materials are comprised of air! This man-made gel that has had its liquid component replaced by a gas is the basis for this porous, ultra-light substance. A highly solid body with a very low density and poor heat conductivity is the end product. It feels like fragile polystyrene foam to the touch. Aerogels can be made of a variety of chemical compounds. It was first produced in 1931 as the brainchild of Samuel Stephens Kistler. He argued that he could replace liquid with gas without shrinking the structure. The first aerogels were made of silica gels. Kistler's later work concerned aerogels based on aluminium oxide, chromium oxide and tin dioxide. Carbon aerogels were first developed in the late 1980s. A special feature of aerogels is that they can have a lower thermal conductivity than that of the gas they contain. This material is an excellent thermal insulator, so it is widely used for environmentally friendly and efficient thermal insulation on an industrial scale. Due to the high and fine porosity of the structure, aerogels can be used as a collecting matrix for the smallest dust particles.

Richlite

Richlite is a strong paper composite material. It is made of waste paper that has been compressed into smooth, hard panels that can be processed. One of Richlite's main advantages is that properly sourced paper is significantly more environmentally friendly than many of the most popular building materials. However, technology transforms it into an amazing raw material that is crucial for eco-construction. Unlike stone or other hard surfaces, Richlite works the same way as dense hardwood, and it can be easily milled, sanded, and joined. Richlite is also a water-resistant and hygienic material that has low moisture absorption, high heat resistance and fire resistance. It doesn’t hurt that it looks good, with a natural finish. As a result, it is used in many industries, from construction to furniture design. It’s even used to produce musical instruments, replacing expensive ebony while providing high sound quality. Richlite has turned out to be a well-known material, loved by many architects as a finish for furniture, interior elements and creative structures.

Hydro ceramics (Passive Cooling)

The interiors of buildings may be cooled by up to 6 °C with this composite facade material, which is constructed of clay and hydrogel. In order to produce a construction system that "becomes a living entity as part of nature, not outside it" hydro ceramics uses the hydrogel's capacity to absorb 500 times its own weight in water. At the Institute for Advanced Architecture of Catalonia, Spanish students created the technology back in 2014. Since then, the architecture community as well as the building industry have experienced a significant increase in demand for this ground-breaking material that permits self-cooling systems. As it may reduce overall energy consumption of conventional cooling equipment by up to 28%, it is particularly well-liked for eco-construction.

2.2.5 Overview of the Nigeria construction industry

Several articles have been published about how distinctive the building construction industry is, especially when compared to other fundamental industries like manufacturing and mining. Some people think of the building construction industry as a collection of industries, or a meta-industry, with many players rather than as a single industry. Building construction projects are generally unique, carried out in various places, and frequently include the utilization of multiple teams, setting them apart from other industries (Fernández-Sols, 2008).

Interests between owners and contractors are out of alignment, and there are market failures such fragmentation and transparency, according to Barbosa et al. (2017). Such circumstances suggest that change in the building construction industry is required to offset this slow state of progress. Indeed, change is not a new phenomenon for industry participants. As Erdogan et al. (2005) note, construction companies are used to dealing with change at the project level (such as design changes) but not necessarily at the organisation level (for example, adopting new ways of doing things). Such organisation-level change may be difficult for construction companies due to geography, organisational structure, size and the multi-disciplinary and bespoke nature of projects. Notwithstanding these challenges, the Barbosa et al. (2017) note that change may not be a distant prospect, given that there are currently signs of potential disruption in parts of the global construction industry.

Construction industry refers to the industrial branch of manufacturing and trade related to building, repairing, renovating, and maintaining infrastructures. It is a determinant of the country's technological and technical advancement, often regulating the growth of the country's infrastructural development that often directs to the country's advancement in terms of sustainability assurance. The construction industry is project-based, where multiple stakeholders form temporary and complex networks of organizations in each new construction project (Dubois et al., 2019,)

The building construction industry is one of the most important in modern economics. The construction industry has outgrown all other sectors of the Nigerian economy. It is one of the most important industries of any given economy. The significance of this industry is often measured by considering its impact on the economy through quantities such as its contribution to the Gross Domestic Product (GDP) and the amount of employment it creates. According to (Ford et al., 2020) Gross Domestic contributed about 11.9% of Nigerian.

The building construction industry is leveraging technology to make construction management and site operations more efficient and sustainable. The major construction industry trends include building information modeling (BIM), construction robotics, and the use of advanced building materials. Further, the COVID-19 pandemic creates the need for newer ways of construction that adhere to worker safety and regulations. Hence, startups and scaleups increasingly develop innovations around prefabrication, worker safety, and construction robotics. Parallelly, 3D printing and green building solutions significantly reduce the negative impacts of construction on the environment

The Nigerian economy's construction sector is a crucial industry, states Dantata (2008). The construction industry is defined as (i) the construction contracting sector; (ii) the provision of construction-related professional services; and (iii) the supply of construction-related goods and materials, according to the Department for Business Innovation and Skills (DBIS) (2013). The construction industry is a system that includes all of the practitioners, including the clients, the contractors, the subcontractors, and the consultants, as well as those involved in the production, supply, and distribution of building supplies. It also includes the construction training schools from technical to research institutes, to polytechnics and to universities. In as much as the construction industry is locomotive in economy, it is plagued with the challenge of adopting these innovative works in the building construction industry.

The construction industry is important to the Nigeria economy to economic growth. According to the Nigeria Bureau of Statistics (2022), the construction industry contributed N12. 9 trillion to the Gross Domestic Product (GDP) in the first quarters of 2022, and was among the largest contributors to the Nigeria Gross Value.Compounding this, the built environment supports significant economic and social activities and has a wide range of responsibilities that include enhancing quality of life (Manseau, 2003).

2.2.6 Innovation and the Building construction industry

The practice and acceptance of innovation is intertwined with change and the adoption of new ways. Gambatese and Hallowell (2011) define innovation as positive change that results from the implementation of new ideas. Without innovation, there would be little motivation to change and few new ways to adopt. Alsher (2017) cautions, however, that innovation in and of itself can be complex. It usually involves large-scale and highly complex organizational change, with multiple interdependencies. Even so, there is a natural imperative to innovate and adapt, given that organizations cannot avoid changing if they are to survive (D'Ortenzio, 2012). Although writing in the mid-20th century, Stewart (1957) highlights that innovation is typically high in expanding industries where change breeds change. This is as relevant in today's era of rapid technological advancement as it was in Stewart's time. It indicates that momentum, or sustained innovation, is required to successfully encourage industries or organizations to adopt new ways. Such momentum may be a key enabler to adopting new ways in the building and construction industry.

The higher level of innovation in the construction industry, the greater the likelihood the industry will increase and improve in the performance of building construction project, and rendering better quality service. Unfortunately, challenges to the building construction industry make it difficult to assess innovation.For example, coping with rapid changes in customer demands for increasingly functional and sophisticated buildings and equipment; offering flexibility whilst anticipating capital and operational cost reduction; increased building renewal/maintenance requirements; globalization of markets, and new technologies providing major transformational effects on the industry. Compound this with difficulties relative to problems of knowledge sharing, industry fragmentation, lack of skilled personnel for example; have resulted in a lack of capability for construction industries to be innovative (Manseau, 2003).

2.3 Review of empirical related studies

2.3.1 Challenges in adopting innovative works in building construction industry

If Barbosa et al. (2017) are correct in noting that change in the global construction industry is not a distant prospect, it is timely to examine the possible barriers to the uptake of such change. This will prepare the industry to overcome identified barriers and challenge.The perceived cultural resistance to change that is pervasive across the industry and clients (Farmer, 2016).Farmer (2016) identifies 10 symptoms of failure and poor performance in the UK construction industry. Two of these are relevant to adopting new ways, including a lack of research and development and investment in innovation and a lack of collaboration and improvement culture. These barriers to change are examined in further detail below.

Gambatese and Hallowell (2011) consider that innovation in the construction industry requires three components: idea generation, opportunity and diffusion. It follows that, if time and financial investment are not made at the idea-generation stage, then opportunity is not provided and the diffusion of innovation will not occur. Farmer (2016) further identifies a 'chicken and egg' impasse within the industry, whereby innovation tends to require proof of concept before it is widely adopted. However, technically and commercially proving a concept cannot occur until it is adopted or deployed at scale. This is also noted by Gambatese and Hallowell (2011) who believe there is a greater level of diffusion of innovative products as the perceived risk of failure decreases. Risk is a recurrent barrier to change in the literature reviewed. Difficulties are identified in getting new products and propositions to market at any scale, due to a deep-seated perception of risk within the wider supply chain. The barrier is the desire for a robust, if not guaranteed, benefits case before a new product or proposition is adopted (Farmer, 2016).

A lack of collaboration is also seen as a challenge in adopting new ways in the building construction industry. Farmer (2016) identified a collaboration problem as being the root cause of the UK construction industry's change inertia. A lack of collaboration is seen to prevent the industry scaling up, sharing risk more appropriately and, potentially, from adopting new ways. Another aspect dis-incentivising collaboration is seen to be a fundamental unwillingness to divulge competitive advantage or intellectual property (Farmer, 2016). Commercial sensitivity is therefore a major barrier to overcome in implementing change as it relates to adopting new ways that may give some industry participants a competitive advantage over others.

Westpac (2017) suggests that a reluctance to invest in people, processes, new technologies and products has contributed to relatively low rates of innovation in the industry. The risk-averse nature of the global industry is also mirrored locally, resulting in a focus on operational issues and making it difficult for firms to invest time and money developing, learning and adopting new approaches. As a result, new products are slow to be introduced to market, and due to a perceived level of risk, diffusion can be sluggish.

Akintayo.O. etal (2021), state that the South African construction industry appears to be lagging behind than other industries in the country in terms of implementation and adoption of innovative technologies. Moreover, sufficient empirical data on the adoption of innovative technologies, especially, in developing countries are not readily available. The aim of this study is therefore to assess the adoption and implementation of innovative technologies in the South African construction industry with a view to improving the industry's performance. A survey was undertaken using a questionnaire, administered to construction professionals primarily in project management, quantity surveying and architectural firms.

The key findings show that there are some innovative technologies such as building information modelling, 3-dimensional mapping, drones, 3-dimensional printing and virtual reality that have been deployed. However, limited adoption of innovative technologies within the industry and low levels of knowledge of its benefits among the respondents were reported. This low implementation of innovative technologies was due to critical barriers such as high cost, limited knowledge, time requirement, fear of change, lack of interest, nature of construction processes and lack of team dynamics. Key drivers of innovation were found to include globalization and competition.

The current level of implementation of innovative technologies indicated that they are not yet optimized in the South African construction industry and suggests implications for change, adaptation and growth.

The study recommends that firms should consider investing in research and development in order to exploit the potential of innovation for organizations and the industry at large. The drivers and barriers indicated will help to prioritize the direction of adoption and growth which could help to improve the industry.

Koki Arai and Emi Morimoto (2021) states that innovation was accessed at three levels: the firm growth account level, the firm behavior level and the level of the firm's experts. The factors influencing innovation at each level were identified and synthesized into guiding strategies for innovation.

Three methods were combined to develop a mode of thinking for innovation. First, at the semi-macro level, the authors identified the factors that influence the total factor productivity (TFP) by regressing the TFP across firms of the construction industry on a variety of extrinsic factors. Second, at the firm level, the authors extracted actual innovative firms from a large amount of public procurement individual data. The authors analyzed the behaviors of these innovative firms. Third, the authors conducted a survey of expert-level personnel. In addition, a text analysis was performed to determine what was perceived by experts as a factor that leads to innovation.

The authors analyzed the total factor productivity (TFP), the behavior of innovative firms and the perception issues between industry experts and stakeholders regarding innovation. As a result, two factors were identified. The first factor was the expectation of a positive solution to the problem through monopoly profits, future benefits and increased efficiency. The second factor was peer pressure from other organizations of a similar nature, peer pressure from users and technical information, as well as competitive conditions, e.g. recent environmental growth, including relevant innovations. In the context of innovation, static and dynamic thinking were important requirements. Static concepts were based on the accumulation of knowledge, such as patents and technological progress. Dynamic thinking involved a future outlook, including a competitive environment as a necessary condition. Actual technological innovation was driven by incentives and expectations.

According to the results of this study, the authors make the following recommendations for enhancing the construction-industry innovation in Japan: do not rely on a patent policy to drive innovation, create an environment that encourages competition and develop an ongoing initiative that encourages and rewards innovation.

Juan M. D. (2019) that the construction industry is a major economic sector, but it is plagued with inefficiencies and low productivity, Robotics and automated systems have the potential to address these shortcomings; however, the level of adoption in the construction industry is very low. This paper presents an investigation into the industry-specific factors that limit the adoption in the construction industry. A mixed research method was employed combining literature review, qualitative and quantitative data collection and analysis. Three focus groups with 28 experts and an online questionnaire were conducted. Principal component and correlation analyses were conducted to group the identified factors and find hidden correlations. The main identified challenges were grouped into four categories and ranked in order of importance: contractor-side economic factors, client-side economic factors, technical and work-culture factors, and weak business case factors. No strong correlation was found among factors.

This study will help stakeholders to understand the main industry-specific factors limiting the adoption of robotics and automated systems in the construction industry. The presented findings will support stakeholders to devise mitigation strategies.

Building construction industries are the main contributor to technological innovation in the construction industry, but the driving process of their innovative works has not yet been fully investigated in previous studies. The purpose of this study is to provide quantitative analysis of the innovative works driving process of building construction industries.

2.4 Summary of Literature Review

The literature review that has been prepared for this study starts off by describing the innovative works and the system of the building construction industry in Abuja, and then goes on to discuss the difficulties in adopting innovations in the construction industry. Several definitions of innovation, contemporary innovative works, and obstacles to embracing innovation in the building construction industry were demonstrated via the opinions or theoretical frameworks of various writers. Similar to how housing is essential for an individual to operate properly in his surroundings, building construction projects are ongoing throughout each day of our lives.

Apart from the fact that building construction projects are daily tasks due to their importance to humanity, they also require a number of steps that must be taken in order to produce and execute a high-quality and functional building construction project. Most of these procedures are complex, demanding, and challenging. However, different people from various professions, including architects, builders, designers, engineers, contractors, clients, etc., work together to achieve these processes, yet they are prone to errors and criticism for lacking in innovation and likely incompetent in some areas, which may lead to the clients becoming dissatisfied with the project work if expected results are not met. But the solution might be found by embracing and adhering to the efficient use of some innovations created for the construction industry.

So, the goal of this study is to assess innovative work and its significance in the construction industry and thebest methods for implementing innovative work in order to enhance the performance of higher-quality building projects in Nigeria.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter describes the methods employed to carry out the research that yields the required data. It focused on the research design, the study area, the population, the sample instrument used for data collection, the instrument validation, the administration of the instruments, and the methods used for data analysis. A successful outcome will be attained with the aid of a solid research plan.

3.1 Design of Study

This study was conducted using a survey research design, which includes gathering data from a sample of respondents by having them respond to questionnaires. People's ideas, attitudes, and thoughts on a certain occurrence can be effectively collected using this study approach. The survey research design was chosen as an acceptable methodology for this study because it asks respondents for their opinions on the innovative efforts made in the construction industry in Abuja.

3.2 Area of the Study

The study will be conducted in Abuja, which is a council district of the Federal Capital Territory of Abuja, situated in the middle of the nation (FCT). Abuja, the capital of Nigeria, is where the city's administration is handled by the local government. Being an urban area, Abuja Municipal has an undetermined number of towns and districts. Therefore, in order to enrich the researcher’s data, three (3) towns Maitama, Wuse, and Utako were selected and one (1) building construction industry was selected from each of these towns respectively. Abuja was chosen for this due to its accessibility to the researcher and there is a reasonable number of building construction industries available to carry out the research.

3.3 Population of the Study

The population consisted of Builders/Contractors and project/site managers who are currently working in the selected Abuja industries, Population of 60 building construction practitioners were used for the study of selected industries Maitama 20, wuse 20 and Utako 20. Given the total numbers of Builders/Contractors to be 24 and total numbers of project/Site managers to be 36 as well.

Table 3.3: Distribution of the Population

S/N	Building construction Industry	No of respondents (practitioners)
1	Dumez Nigeria Plc, Maitama, Abuja FCT Nigeria	20
2	Urban Shelter Properties, Wuse 5, Abuja Nigeria	20
3	Reg Buildings & Interior , Utako, Abuja FCT Nigeria	20
	Total	60

3.4 Sample and Sampling Techniques

As the intent of the researcher is to assess the innovative works in the building construction industry, the entire population was used for the study, since the population is of a controllable size. As such, there was no sampling technique.

3.5 Instrument for Data Collection

The instrument to be used for data collection is a well-designed questionnaire developed by the researcher for the purpose of this study. Questionnaire is one of the primary instruments for data collection in quantitative research (Roopa& Rani, 2012). The questionnaire developed is divided into two (2) parts, namely Part A, and Part B. Part A contains the personal information of the respondent while Part B is further divided into three (3) sections.

Section I: this consists of 12 items which deals with assessing the innovative works in building construction industries in Abuja. Section II: this consists of 11 items that deals with the challenges in adopting innovative works in building construction industries in Abuja. Section III: this consists of 12 items which deals with recommending strategies to promote the adoption of innovative works in building construction industries in Abuja.

3.6 Validation of Instrument

The questionnaire for this study was validated by three lecturers in the Department of Industrial and Technology Education (ITE), Federal University of Technology Minna, Niger State. The essence of this is to assess the clarity and the appropriateness of the questionnaire items. Their comments and suggestions were used to modify and restructure the instrument for the final draft.

3.7 Administration of the Instrument

The questionnaire was administered online by the researcher with the help of two research assistants. The research assistants were educated on the contents of the instrument. Concepts were explained and the standards of responses discussed.

3.8 Method of Data Collection

Data was collected using structured questionnaires with closed-ended questions. The distribution and collection was done by two research assistant under the directive of the researcher. Among the 60 copies of the questionnaire distributed, all were duly returned and used for data analysis.

3.9 Method of Data Analysis

The data collected by the researcher was analyzed using mean, standard deviation and t- test. Mean and standard deviation was used for the items of the research questions while t-test was used to test the hypotheses formulated for the study.

The Mean score of 2.50 and above on a four-point rating scale will be used as a cut-off point test. Any item that attract up to 2.50 and above will be considered as agreed or available and any below 2.50 will be considered as disagree or not available. Hypotheses are accepted where t-calculated is less than t-table value and will be rejected where they are equal or greater than t-table value. The null hypotheses will be tested using an inferential statistics t-test at 0.05 level of significant.

Research question 1, 2 and 3 was responded to using the following rating scale

Strongly Agree (SA) = 4

Agree (A) = 3

Disagree (D) = 2

Strongly Disagree (SD) = 1

The above rating point scales, was used to determine and to analyze the outcome of the research questions, to note the level of response from the respondent when the questionnaire was presented.

CHAPTER FOUR

RESULT AND DISCUSSIONS

This chapter present analyses, and interprets data obtained from the responses to the questionnaire. It discusses findings, with respect to the **"**Research Objectives**"**.

4.1 Research Question 1: what are the Innovative works in the Building Construction Industry?

Table 4.1: below revealed the Mean Responses and the Standard Deviation of Project/Site Managers and Builders on the Innovative Works in Building Construction Industry in Abuja.

Source: Field Survey, 2023 (N_1= 24, N_2 = 36)

Grand mean $\overline{X_1}$= **3.24** Grand mean $\overline{X_2}$= **3.30**

S/N	ITEM	$\overline{X_1}$	SD_1	$\overline{X_2}$	SD_2	$\overline{X_t}$	SD_t	REMARK
1	Bioplastics materials	3.17	0.48	3.39	0.73	3.28	0.18	Agreed
2	Aerogel materials	3.25	0.53	3.22	0.76	3.24	0.16	Agreed
3	Automatic danger warning system	3.67	0.56	3.53	0.65	3.6	0.06	Agreed
4	Robotics	3.04	0.55	3.08	0.87	3.06	0.23	Agreed
5	Cloud-base software	3.13	0.74	3.22	0.68	3.18	0.04	Agreed
6	Artificial Intelligence (AI)	3.29	0.75	3.22	0.87	3.26	0.08	Agreed
7	Building Information Modelling (BIM)	3.63	0.49	3.58	0.65	3.61	0.11	Agreed
8	3D printing	3.46	0.66	3.42	0.69	3.44	0.02	Agreed
9	Off-Site construction	3.33	0.56	3.39	0.6	3.36	0.03	Agreed
10	Transparent wood	2.75	0.9	2.92	0.87	2.84	0.02	Agreed
11	Richlite materials	3.08	0.58	3.42	0.65	3.25	0.05	Agreed
12	Hydroceramics materials	3.13	0.68	3.31	0.75	3.22	0.05	Agreed

KEY:

$\overline{X_1}$ = Mean Response of Builders

$\overline{X_2}$ = Mean Response of Project/Site Managers

SD_1 = Standard Deviation of the Mean Response of Builders

SD_2= Standard Deviation the Mean Response of Project/Site Managers

$\overline{X_t}$ = Mean of mean or average responses of Builders and Project/Site Managers

N_1 = Number of Builders

N_2 = Number of Project/Site Managers

The result on **table 4.1** shown above revealed that items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12 were agreed as the Innovative works in the Building Construction Industry since the item values are within the range of (2.84 – 3.61) on the cut-off point of 2.50.

This signifies that the twelve (12) items are the Innovative works agreed in the Building Construction Industry.

4.2 Research Question 2: What are the challenges in adopting Innovative works in the Building Construction Industry?

Table 4.2 below revealed the Mean Responses and the Standard Deviation of Project/Site Managers and Builders on the challenges in adopting Innovative Works in Building Construction Industry in Abuja.

Source: Field Survey, 2023 (**N_1**= 24, **N_2** = 36)

S/N	ITEM	$\overline{X_1}$	SD_1	$\overline{X_2}$	SD_2	$\overline{X_t}$	SD_t	REMARK
1	Incompetent project management skills and strategies	3.29	0.69	3.47	0.7	3.38	0.01	Agreed
2	Conflicting goals among team workers	3.25	0.53	3.36	0.64	3.31	0.08	Agreed
3	The drive for efficiency	3.29	0.55	3.08	0.65	3.19	0.07	Agreed
4	Lack of innovative investment procedure practices	3.29	0.62	3.25	0.6	3.27	0.01	Agreed
5	Lack of creation of knowledge network within the building construction industry	3.04	0.55	3.25	0.73	3.15	0.13	Agreed
6	Shortage of data and information sharing in and outside the box of the industry	3.13	0.45	3.36	0.68	3.25	0.16	Agreed
7	Inadequate Training and Supervision	3.38	0.65	3.42	0.81	3.4	0.11	Agreed
8	Lack of recognition of the value of the Innovation	3.25	0.61	3.17	0.7	3.21	0.06	Agreed
9	Lack of technical competency of innovation champion and gurus	3.29	0.62	3.22	0.9	3.26	0.2	Agreed
10	Belief that the industry is doing well without innovations	3.00	0.72	3.03	0.88	3.02	0.11	Agreed
11	Government policy	3.33	0.7	3.47	0.56	3.4	0.1	Agreed

KEY:

$\overline{X_1}$ = Mean Response of Builders

$\overline{X_2}$= Mean Response of Project/Site Managers

SD_1 = Standard Deviation of Response of Builders

SD_1 = Standard Deviation of Response of Project/Site Managers

$\overline{X_t}$ = Mean of mean or average responses of Builders and Project/Site Managers

N_1 = Number of Builders

N_2 = Number of Project/Site Managers

The result on **table 4.2** shown above revealed that items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, & 11 were agreed as the challenges in adopting Innovative works in the Building Construction Industry since the item values are within the range of (3.38 – 3.02) on the cut-off point of 2.50.

This signifies that the eleven (11) items are the challenges in adopting Innovative works agreed in the Building Construction Industry.

4.3 Research Question 3: What are the recommended strategies to adopting Innovative works in the Building Construction Industry?

Table 4.3 below revealed the Mean Responses and the Standard Deviation of Project/Site Managers and Builders on the recommended strategies to adopting Innovative Works in Building Construction Industry in Abuja.

Source: Field Survey, 2023 (**N_1**= 24, **N_2** = 36)

S/N	ITEM	$\overline{X_1}$	SD_1	$\overline{X_2}$	SD_2	$\overline{X_t}$	SD_t	REMARK
1	The management should provide adequate and competent management skills and strategies	3.75	0.44	3.69	0.58	3.72	0.1	Agreed
2	The management should Build networks of support among individuals and teams within the organization	3.58	0.5	3.72	0.45	3.65	0.04	Agreed

3	The management should Create an environment where there are creativity and innovation thrive by providing the tools, resources, and support for the team members to be creative and innovative	3.67	0.48	3.64	0.49	3.66	0.01	Agreed
4	The management should organize workshops, seminars, and conferences for their team members on the value of innovation	3.63	0.49	3.75	0.44	3.69	0.04	Agreed
5	The management should Introduce an idea and data sharing platform	3.46	0.51	3.53	0.56	3.5	0.04	Agreed
6	The management should Implement new ideas and strategies and encouraging employees to think outside the box	3.58	0.58	3.61	0.49	3.6	0.06	Agreed
7	The management should Promote open communication channels throughout the organization	3.54	0.59	3.56	0.5	3.55	0.06	Agreed
8	Manager and team workers should foster new thinking and challenge the status quo of the industry and be open to new ideas and innovations	3.5	0.51	3.58	0.55	3.54	0.03	Agreed
9	The management should Cultivate a culture that values new technology and encourages risk-taking	3.58	0.5	3.5	0.56	3.54	0.04	Agreed
10	The management should Provide resources needed for success such as the latest technology and software, as well as access to experts	3.54	0.51	3.56	0.65	3.55	0.1	Agreed
11	The management should create an environment that is supportive and encouraging, and by giving team members the freedom to experiment with new ideas and innovation	3.54	0.51	3.47	0.56	3.51	0.04	Agreed
12	The government should recognize, encourage and reward those organizations who are creative and adopt innovation successfully	3.5	0.51	3.56	0.65	3.53	0.1	Agreed

KEY:

$\overline{X_1}$ = Mean Response of Builders

$\overline{X_2}$ = Mean Response of Project/Site Managers

SD_1 = Standard Deviation of Response of Builders

SD_1 = Standard Deviation of Response of Project/Site Managers

$\overline{X_t}$ = Mean of mean or average responses of Builders and Project/Site Managers

N_1 = Number of Builders

N_2 = Number of Project/Site Managers

The result on **table 4.3** shown above revealed that items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12 were agreed as the recommended strategies to adopting Innovative works in the Building Construction Industry since the item values are within the range of (3.50 – 3.72) on the cut-off point of 2.50.

This signifies that the twelve (12) items are the recommended strategies to adopting Innovative works agreed in the Building Construction Industry.

4.4 Research Hypotheses 1: There is no significant difference in mean responses of the Builders, and the Project/Site Managers as regards the innovative works in building construction industry.

Table 4.4 below revealed the Mean, Standard Deviation, and T-cal Analysis of the Responses of Project/Site Managers and Builders on the recommended strategies to adopting Innovative Works in Building Construction Industry in Abuja.

Source: Field Survey, 2023 (**N_1**= 24, **N_2** = 36)

S/N	ITEM	SD_1	SD_2	T-Cal	REMARK
1	Bioplastics materials	0.48	0.73	-1.95	NS
2	Aerogel materials	0.53	0.76	0.24	NS
3	Automatic danger warning system	0.56	0.65	1.11	NS
4	Robotics	0.55	0.87	-0.3	NS
5	Cloud-base software	0.74	0.68	-0.55	NS
6	Artificial Intelligence (AI)	0.75	0.87	0.4	NS
7	Building Information Modelling(BIM)	0.49	0.65	0.45	NS
8	3D printing	0.66	0.69	0.27	NS
9	Off-Site construction	0.56	0.6	-0.48	NS

10	Transparent wood	0.9	0.87	-0.83	NS
11	Richlite materials	0.58	0.65	-2.61	NS
12	Hydroceramics materials	0.68	0.75	-1.17	NS

KEY:

T-Cal = t-test calculated

T-Critical = 1.960

NS = No significant differences

SD_1 = Standard Deviation of Response of Builders

SD_2 = Standard Deviation of Response of Project/Site Managers

N_1= Number of Builders

N_2= Number of Project/Site Managers

The result on **table 4.4** shown above revealed that all the items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12 were less than the critical value (1.960) at 0.05 level of significant. This signifies that the null hypotheses which stated that there is no significant difference in mean responses of the builders, and the project/site managers as regards the innovative works in building construction industry is accepted at 0.05 level of significant.

4.5 Research Hypotheses 2: There is no significant difference in mean responses of the Builders, and the Project/Site Managers as regards the challenges in adopting innovative works in building construction industry**.**

Table 4.5 below revealed the Mean, Standard Deviation, and T-cal Analysis of the Responses of Project/Site Managers and Builders on the challenges in adopting innovative works in building construction industry

Source: Field Survey, 2023 (N_1= 24, N_2 = 36)

S/N	ITEM	SD_1	SD_2	T-Cal	REMARK
1	Incompetent project management skills and strategies	0.69	0.7	-1.17	NS
2	Conflicting goals among team workers	0.53	0.64	-0.92	NS
3	The drive for efficiency	0.55	0.65	1.69	NS
4	Lack of innovative investment procedure practices	0.62	0.6	0.29	NS
5	Lack of creation of knowledge network within the building construction industry	0.55	0.73	-1.65	NS
6	Shortage of data and information sharing in and outside the box of the industry	0.45	0.68	-2.2	NS
7	Inadequate Training and Supervision	0.65	0.81	-0.27	NS
8	Lack of recognition of the value of the Innovation	0.61	0.7	0.58	NS
9	Lack of technical competency of innovation champion and gurus	0.62	0.9	0.47	NS
10	Belief that the industry is doing well without innovations	0.72	0.88	-0.18	NS
11	Government policy	0.7	0.56	-0.92	NS
12	Incompetent project management skills and strategies	0.69	0.7	-1.17	NS

KEY:

T-Cal = t-test calculated

T-Critical = 1.960

NS = No significant differences

SD_1 = Standard Deviation of Response of Builders

SD_2 = Standard Deviation of Response of Project/Site Managers

N_1= Number of Builders

N_2= Number of Project/Site Managers

The result on **table 4.5** shown above revealed that all the items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, & 11, were less than the critical value (1.960) at 0.05 level of significant. This signifies that the null hypotheses which stated that there is no significant difference in mean responses of the builders, and the project/site managers as regards the challenges in adopting innovative works in building construction industry is accepted at 0.05 level of significant.

4.6 Research Hypotheses 3: There is no significant difference in mean responses of the Builders, and the Project/site Managers as regards the recommended strategies to promote the adoption of innovation in building construction industry.

Table 4.6 below revealed the Mean, Standard Deviation, and T-cal Analysis of the Responses of Project/Site Managers and Builders on the recommended strategies to promote the adoption of Innovation in building construction industry.

Source: Field Survey, 2023 (**N_1**= 24, **N_2** = 36)

S/N	ITEM	SD_1	SD_2	T-Cal	REMARK
1	The management should provide adequate and competent management skills and strategies	0.44	0.58	0.61	NS
2	The management should Build networks of support among individuals and teams within the organization	0.5	0.45	-1.3	NS
3	The management should Create an environment where there are creativity and innovation thrive by providing the tools, resources, and support for the team members to be creative and innovative	0.48	0.49	0.29	NS
4	The management should organize workshops, seminars, and conferences for their team members on the value of innovation	0.49	0.44	-1.14	NS
5	The management should Introduce an idea and data sharing platform	0.51	0.56	-0.62	NS
6	The management should Implement new ideas and strategies and encouraging employees to think outside the box	0.58	0.49	-0.24	NS
7	The management should Promote open	0.59	0.5	-0.16	NS

	communication channels throughout the organization				
8	Manager and team workers should foster new thinking and challenge the status quo of the industry and be open to new ideas and innovations	0.51	0.55	-0.71	NS
9	The management should Cultivate a culture that values new technology and encourages risk-taking	0.5	0.56	0.72	NS
10	The management should Provide resources needed for success such as the latest technology and software, as well as access to experts	0.51	0.65	-0.17	NS
11	The management should create an environment that is supportive and encouraging, and by giving team members the freedom to experiment with new ideas and innovation	0.51	0.56	0.62	NS
12	The government should recognize, encourage and reward those organizations who are creative and adopt innovation successfully	0.51	0.65	-0.52	NS

KEY:

T-Cal = t-test calculated

T-Critical = 1.960

NS = No significant differences

SD_1 = Standard Deviation of Response of Builders

SD_2 = Standard Deviation of Response of Project/Site Managers

N_1= Number of Builders

N_2= Number of Project/Site Managers

The result on **table 4.6** shown above revealed that all the items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12 were less than the critical value (1.960) at 0.05 level of significant. This signifies that the null hypotheses which stated that there is no significant difference in mean responses of the builders, and the project/site managers as regards the challenges in adopting innovative works in building construction industry is accepted at 0.05 level of significant.

4.6 Findings of the study

Based on the data collected for this study, the analysis and the interpretation, the following are the findings;

1. The builders and the project/site managers were well informed of and have knowledge on the Innovative works in building construction industry.
2. There is no significant difference in mean responses of the builders, and the project/site managers as regards the innovative works as agreed in the building construction industry
3. The builders and the project/site managers were not strangers to the challenges in adopting innovative works in building construction industry**.**
4. There is no significant difference in mean responses of the builders, and the project/site managers as regards the challenges in adopting innovative works in building construction industry
5. The construction builders and the project/site managers were enlightened on the strategies to promoting the adoption of Innovative works in building construction industry
6. There is no significant difference in mean responses of the builders, and the project/site managers as regards the recommended strategies to promote the adoption of innovation in building construction industry

4.7 Discussion of Findings

The discussions of the findings were based on the research questions and the research hypotheses of the study. The data presented in **Table 4.1** contained twelve (12) items which revealed the Innovative works in building construction industry such as Building Information Modeling

(BIM), 3D printing, robotics and automation, drones, prefabrication and modularization, virtual (VR) and augmented reality (AR), and contemporary building materials, with the essence of providing better project results, value for money, sustainability, proper health and safety for employees, and projects that are both cost- and environmentally-efficient. The hypotheses tested on this research question was accepted, which revealed that, there was no significant difference in mean responses of the builders, and the project/site managers as regards the innovative works as agreed in the building construction industry.

The data presented in **Table 4.2** comprised eleven (11) items that brought out into the open, the challenges in adopting innovative works in building construction industry such as Incompetent project management skills and strategies, Inadequate Training and Supervision, Lack of innovative investment procedure practices, Shortage of data and information sharing in and outside the box of the industry etc. The above may result in ineffectual and nonfunctional building construction services. The hypotheses tested on this research question was accepted, which revealed that there was no significant difference in mean responses of the builders, and the project/site managers as regards the challenges in adopting innovative works in building construction industry.

The data presented **Table 4.3** also contained twelve (12) items which revealed the suggested ways to promoting the adoption of innovative works in building construction industry such **as** the management should provide adequate and competent management skills and strategies, the management, should build networks of support among individuals and teams within the organization, Creation of an environment where there are creativity and innovation thrive by providing the tools, resources, and support for the team members to be creative and innovative, organizing of workshops, seminars, and conferences for their team members on the value of innovation, the management should Promote open communication channels throughout the organization etc. The above may not only informed and make the construction Builders and the project/site managers' knowledgeable on the Innovative works in building construction industry but may also provide the technical know-how. The hypotheses tested on this research question was accepted, which revealed that there is no significant difference in mean responses of the builders, and the project/site managers as regards the recommended strategies to promote the adoption of innovation in building construction industry.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary and conclusion derived from the outcome of the study which is to assess the innovative works in the Building construction industry. It also provides recommendations that can be pursued by the industrial management and the building construction practitioners such as Builders and the Project/Site managers.

The study was conducted in Abuja, which is a council district of the Federal Capital Territory of Abuja. The respondents were the building construction practitioners (Builders/Contractors and Project/site Managers). The entire construction practitioners were selected since the population used was of a controllable size. It utilized survey research method, which includes gathering data from the respondents by having them respond to questionnaires. The statistical tools used were mean, standard deviation and t- test. Mean and standard deviation was used for the items of the research questions while t-test was used to test the hypotheses formulated for the study.

5.1 Summary of the Findings

The findings of the study were summarized according to the statement of the problem stated in chapter one.

How comparable are the two groups of respondents in terms of their knowledge on the innovative works in Building construction industry?

The Builders/Contractors has a mean of 3.24 while the Project/Site Managers has a mean of 3.30 and were both on the level above average.

The data also revealed that the T-critical value of 1.960 from the t-table is greater than the t-calculated on the items; hence with 58 degrees of freedom, there is no significant difference between the mean responses of Builders/Contractors and the Project/site Managers in the assessment of the innovative works. Therefore, the null hypothesis is accepted. This revealed that the two groups expressed almost the same proficiency as regarded the knowledge on innovative works in building construction industry before the researcher carried out the assessment.

5.2 Implication of the Findings

The findings indicates that the builders and the project/site managers were well informed of and have knowledge on the Innovative works in building construction industries, with incompetent technical know-how. This finding also infers that the major challenge hindering the adoption of innovative works in building construction industry is incompetent management skills and strategies.

The findings also indicate that provision of adequate and competent management skills and strategies, building of networks of support among individuals and teams within the organization, Creation of an environment where there are creativity and innovation thrive by providing the tools, resources, and support for the team members to be creative and innovative, organizing of workshops, seminars, and conferences for their team members on the value of innovation, and Promoting open communication channels throughout the organization will help in fostering the adoption of innovative works in the building construction industry.

5.3 Contribution to Knowledge

The following contributed to the existing knowledge;

1. Through this study, the researcher was exposed to understanding how distinctive the building construction industry is, especially when compared to other fundamental industries like manufacturing and mining. Building construction projects are generally unique, carried out in various places, and frequently include the utilization of multiple teams, setting them apart from other industries.
2. The researcher was made to understand that, the move to adopt innovative works such as Building Information Modeling (BIM), 3D printing, robotics and automation, drones, virtual (VR) and augmented reality (AR), and contemporary building materials, in the building construction industry has been very slow. The researcher also learnt that few architects have adopted it but mainly for enhancing the visual quality of their presentation, and neglecting its enormous potentials to enhance efficiency (improve building construction outcomes), sustainability, cost efficient, reduce disputes, provide environmentally safe buildings and overall quality of building construction works, and curb corruption.
3. The researcher also affirmed incompetent management skills and strategies as the considerable challenge in adopting innovative works in building construction industry.

4. In general, this study provides an additional level of analysis and understanding that will support the creation of effective mitigation strategies.

5.4 Conclusion

Based on the indicated findings, the following conclusions were drawn:

1. The responses on the Builders/Contractors and the Project/site Managers group has almost the same knowledge on the innovative works in building construction industry.
2. The findings revealed that the building construction practitioners acknowledged that the major challenge in adopting innovative works in building construction industry is; incompetent project management skills and strategies with the total mean of 3.38 above the average.

5.5 Recommendations

This study revealed the recognition and the advantages of the effect of innovative works in building construction industry as an inquiry based strategy in boosting the industry performance, particularly its productivity and efficiency. Thus, the following recommendations are hereby presented:

1. Since the recognition and the advantages of the effect of innovative works in building construction industry has been proven, the Builders/Contractors and the Project/site Managers should incorporate innovations into their building construction work to improve the performance of building construction projects in line with better quality services for their clients and not just be for enhancing the visual quality of their presentation work.
2. The adoption of innovation as an inquiry based strategy in boosting the industry performance, particularly its productivity and efficiency should be encouraged by industrial managers and embraced by Builders/contractors, project/site managers, architects in an

effort to continually improve the overall quality of building construction projects , with better project results, value for money, sustainability, proper health and safety for employees, and projects that are both cost- and environmentally-efficient.

5.6 Suggestion for Further Research

Lastly based on the above findings, future researchers may conduct a similar study on a different setting to discover new knowledge and add to the limited literature on assessing the innovative works in building construction industry and challenges in adopting innovation in building construction industry. The findings also revealed that synergies can be found among different innovative works to fast forward the adoption of new innovative works in the construction industry.

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APPENDIX

Industrial and Technology Education Department
School of Science and Technology Education,
Federal University of Technology,
P.M.B. 65,
Minna,
14th January, 2022.

Dear Sir,

REQUEST FOR FACE VALIDATION OF INSTRUMENT FOR ASSESSING THE INNOVATIVE WORKS IN BUILDING CONSTRUCTION INDUSTRY

I am an undergraduate student of the above named address currently undertaking a study on the topic: ASSESSING THE INNOVATIVE WORKS IN BUILDING CONSTRUCTION INDUSTRY IN ABUJA, NIGERIA.

Attached is the draft copy of the instrument. As an expert in this area, your assistance is hereby solicited to enable me accomplish this task. Kindly go through the item to verify their clarity, relevance and appropriateness in the use of language. In addition to this you can also make further suggestions that will improve the status and quality of the instrument. Your contribution to this work is highly appreciated.

Thanks

Yours faithfully,

THOMAS, HAPPINESS ADZUME
2018/3/74395

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION. INNOVATIVE WORKS AND FRUSTRATION IN BUILDING CONSTRUCTION INDUSTRY IN ABUJA.

Questionnaire Form.

Part 1

Sir/Madam

I am a final Year student of Industrial and Technology education (Building Technology) under the above, named university. I am currently working on assessing Innovative Works in building construction industry as part of the requirement for my B.Tech degree. The questions revolve around the benefits and practicality of innovation in building construction industry in Abuja, Nigeria.

You have been selected to participate in this survey; your responses will be treated with obscurity for academic purposes only. Thanks a bunch for your help.

General information:

1. Please indicate your status:

() Contractor/Builder () Project/ Site manager,

2. Please indicate your gender:

() Male () Female

3. Please indicate your years of experience:

() 0-5 () 5-10 () 10-20 () 20-30() 30 and above.

Instructions:

1. Please rate each item as to your experience (s) using the four (4) points rating scale as shown below.

Strongly Agree (SA).

Agree (A)

Disagree (D)

Strongly Disagree (SD)

2. Please use a tick () for your rating in the space provided for your best option of choice on the item of innovative works and frustration in building construction project.

Objectives of the study:

Specifically, the study seeks to assess;

1. The innovative works in building construction industry
2. The challenges in adopting innovative works in the building construction industry
3. The recommended strategies to promote the adoption of innovative works in the building construction industry

Part 2

Section A

Research question 1: what are the Innovative works in the Building Construction Industry?

S/N	**ITEMS STATEMENT**	**SA**	**A**	**D**	**SD**

1	The use of Bioplastics materials for thermal control in building (steady heating and cooling temperature)				
2	The use of Aerogel materials for sound proofing in building				
3	The use of automatic danger warning system that warns site workers who avail within danger zone				
4	The use of robotics in the reduction of human induce error, losses due to fatigue				
5	The use of cloud-based software for construction project management				
6	The use of Artificial Intelligence (AI) to ensure workers safety and safer work environments				
7	The use of Building Information Modeling (BIM) for efficient planning, designing and construction of buildings				
8	The use of 3D printing for printing architectural models and complex designs				
9	The use of Off-Site construction for fabrication of building materials before transporting it to construction site for efficient construction of permanent structure				
10.	The use of transparent wood as a replacement for glass and plastic windows (cost and quality control)				
11.	The use of richlite materials as a finish for interior design (Eco-friendly material)				
12.	The use of hydroceramics materials for cooling the interior of buildings (decrease energy cost and replace air conditioner)				

Section B

Research question 2: What are the challenges in adopting Innovative works in the Building Construction Industry?

S/N	ITEMS STATEMENT	SA	A	D	SD
1	Incompetent project management skills and strategies				
2	Conflicting goals among team workers (Different goals among team may not work together towards a common goal, and this can ultimately lead to a slower innovation process)				
3	The drive for efficiency (No time or resources to focus on adopting innovation initiatives)				
4	Lack of innovative investment procedure practices (Research and Development (R&D), training and education)				
5	**Lack of creation of knowledge network within the building construction industry (no idea sharing platform)**				
6	Shortage of data and information sharing in and outside the box of the industry				
7	Inadequate Training and Supervision (risk in commercializing innovative works)				
8	Lack of recognition of the value of the Innovation				
9	Lack of technical competency of innovation champion and gurus				
10	Belief that the industry is doing well without innovations				

11	Government policy				

Section C

1. Research question 3: What are the propose effective strategies to promote the adoption of innovative works in the building construction industry?

S/N	ITEMS STATEMENT	SA	A	D	SD
1	The management should provide adequate and competent management skills and strategies				
2	The management should Build networks of support among individuals and teams within the organization				
3	The management should Create an environment where there are creativity and innovation thrive by providing the tools, resources, and support for the team members to be creative and innovative				
4	The management should organize workshops, seminars, and conferences for their team members on the value of innovation				
5	The management should Introduce an idea and data sharing platform				
6	The management should Implement new ideas and strategies and encouraging employees to think outside the box				
7	The management should Promote open communication channels throughout the organization				

8.	Manager and team workers should foster new thinking and challenge the status quo of the industry and be open to new ideas and innovations				
9	The management should Cultivate a culture that values new technology and encourages risk-taking				
10	The management should Provide resources needed for success such as the latest technology and software, as well as access to experts				
11	The management should create an environment that is supportive and encouraging, and by giving team members the freedom to experiment with new ideas and innovation				
12	The government should recognize, encourage and reward those organizations who are creative and adopt innovation successfully				